Integrated Simulation
- from the Main Linac to IP

SLEPT-SAD-CAIN

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Simulation Codes

- Main Linac: SLEPT

  Tracking of slices, which have 2nd order moments in transverse, $\langle y \rangle$, $\langle p_y \rangle$, $\langle y^2 \rangle$, $\langle y p_y \rangle$, $\langle p_y^2 \rangle$, and 1st order in longitudinal, E, z.
- BDS: SAD

  Tracking of macro particles, x, x', y, y', E, z
- IP: CAIN

  Beam-beam using macro-particles, x, x', y, y', E, z

SLEPT-SAD interface is available but not well established.

SAD-CAIN interface is straight forward.

Procedure

- Make data at the end of linacs by SLEPT, for 100 linacs with different random seeds.

  Only in vertical plane.

  (10 x 10 = 100 slices per bunch)

- Tracking by SAD, through BDS. Make data at IP.

  Tentatively, 20 mrad crossing angle “Strawman”, electron side only, is used.

  (10000 macro particles per bunch)

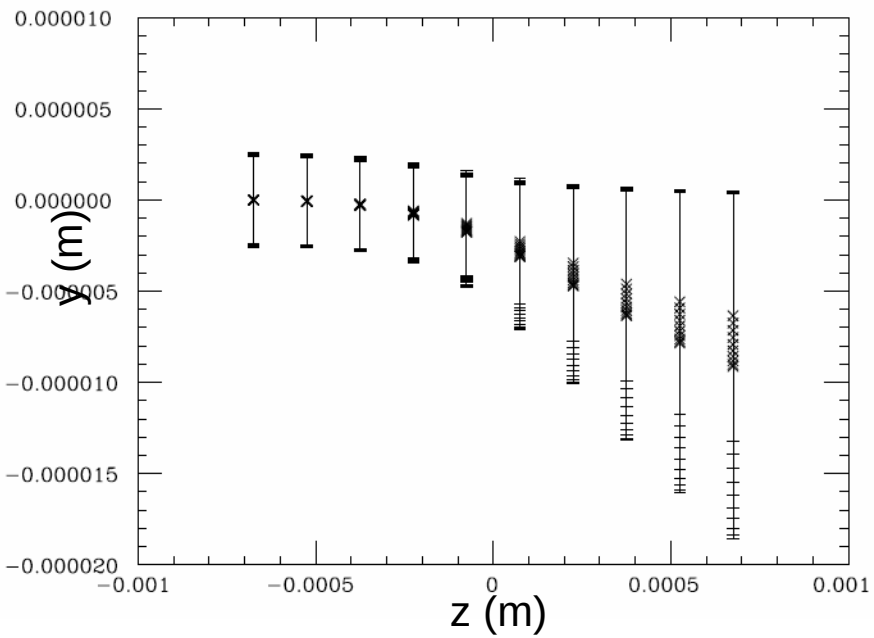
- Beam-beam simulation by CAIN.

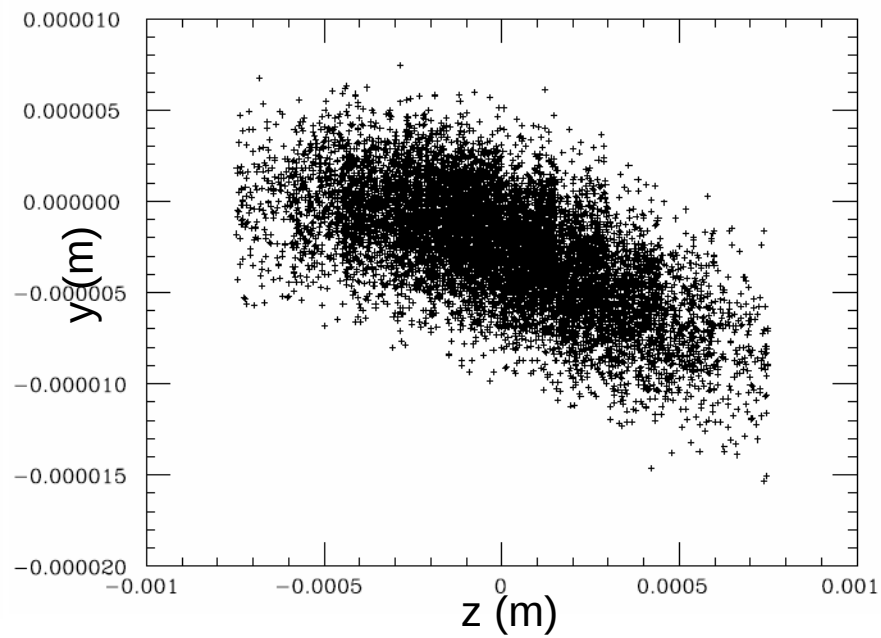
  (2n-1)-th data are regarded as electrons’ and (2n)-th data are regarded as positrons’

  (10000 macro particles per bunch)

Example of Slice data (from SLEPT) to macro particles (for SAD).

Data at the end of Linac.
Cavity misalignment 1.4 mm.





Parameters and conditions -1

Beam parameter at Linac entrance:

2E10 particles/bunch, Initial normalized vertical emittance 2E-8 m,
Bunch length 0.3 mm, Initial momentum spread 2.8%

Errors (only in Main Linac): 3 cases

(a) Quad misalignment (1 μm), no correction.

(b) Cavity misalignment (14 mm), no correction.

(c) Quad, cavity misalignment (300 μm), cavity tilt (300 μrad), tilt compensation and steering correction.

Perfect orbit correction (position and angle) was assumed at IP for all three cases.

Perfect orbit correction was assumed at BDS entrance for the case (c).

Parameters and conditions -2

Horizontal plane:

No simulation in Main Linac.

For downstream, horizontal gauss distribution was assumed.

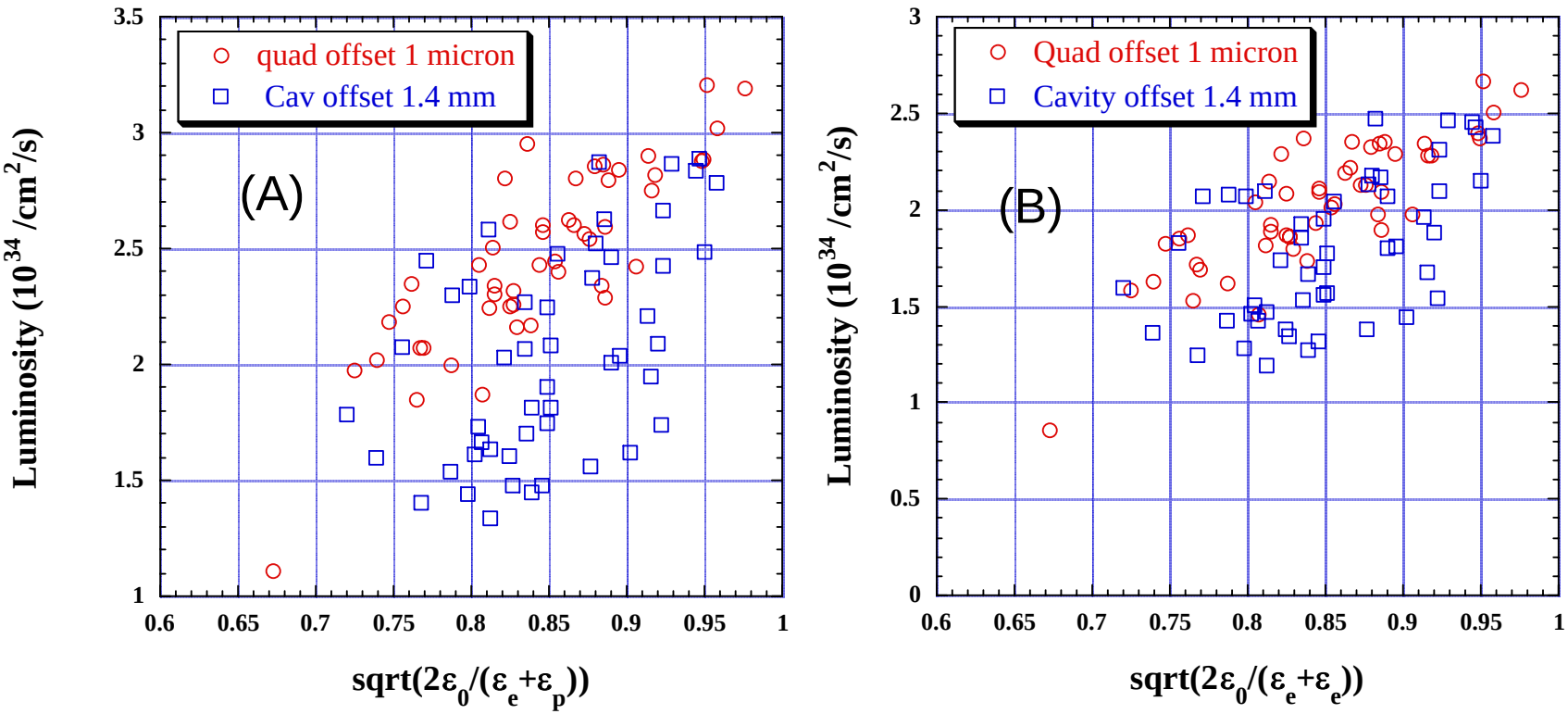
Two cases:

At Main Linac exit, (A) $\gamma\varepsilon_x$=10μm

(B) $\gamma\varepsilon_x$=14μm

Because β^*_x=15 mmat IP, horizontal beam size at IP in (A) is smaller than the “nominal” parameter.

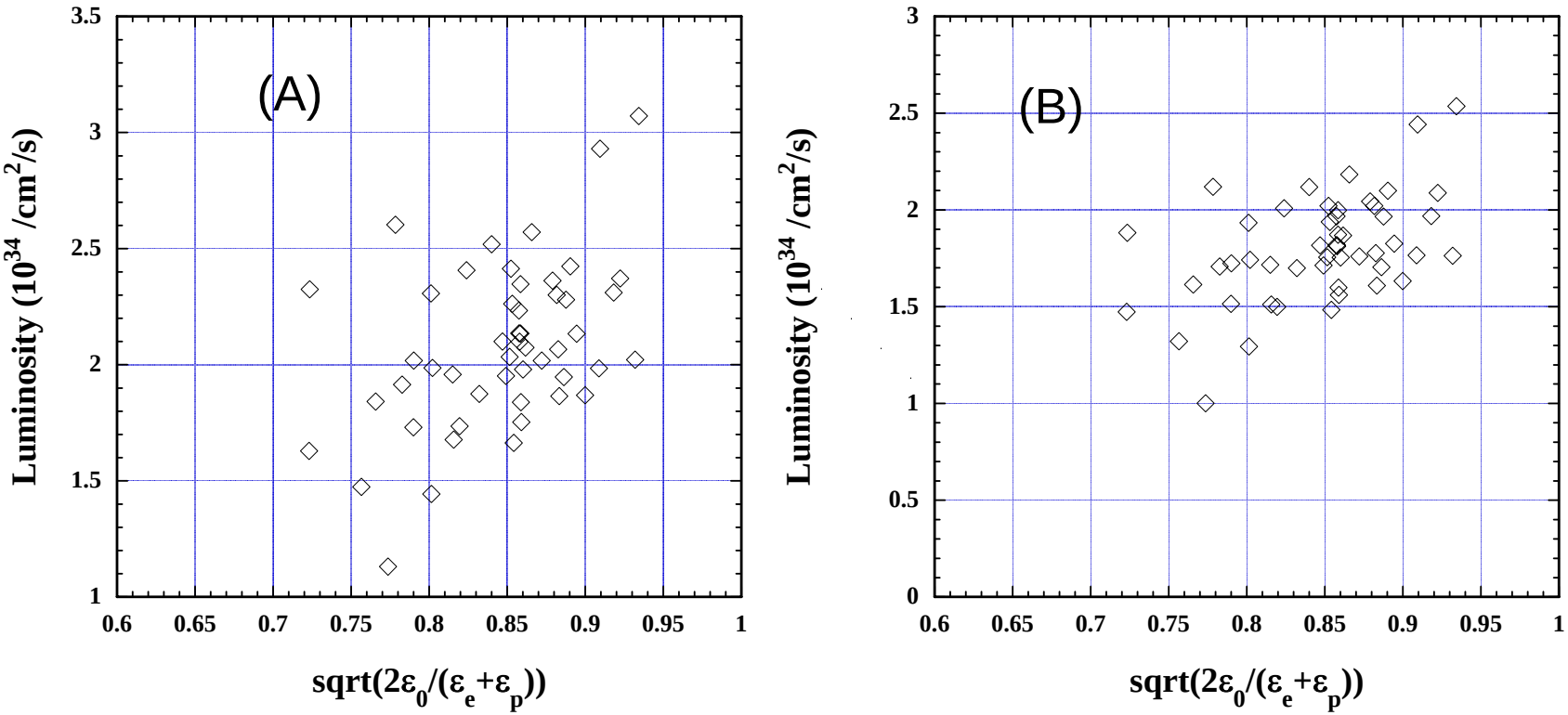
Luminosity (2820 x5 bunch crossing/s) vs.
Sqrt(1/sum. of emittance) at the end of Linac,
100 random seeds



Luminosity should be approximately proportional to
Sqrt(1/sum. of emittance) for beams with Gauss distributions.
Strong “banana” effect is observed in the case of Cavity offset.

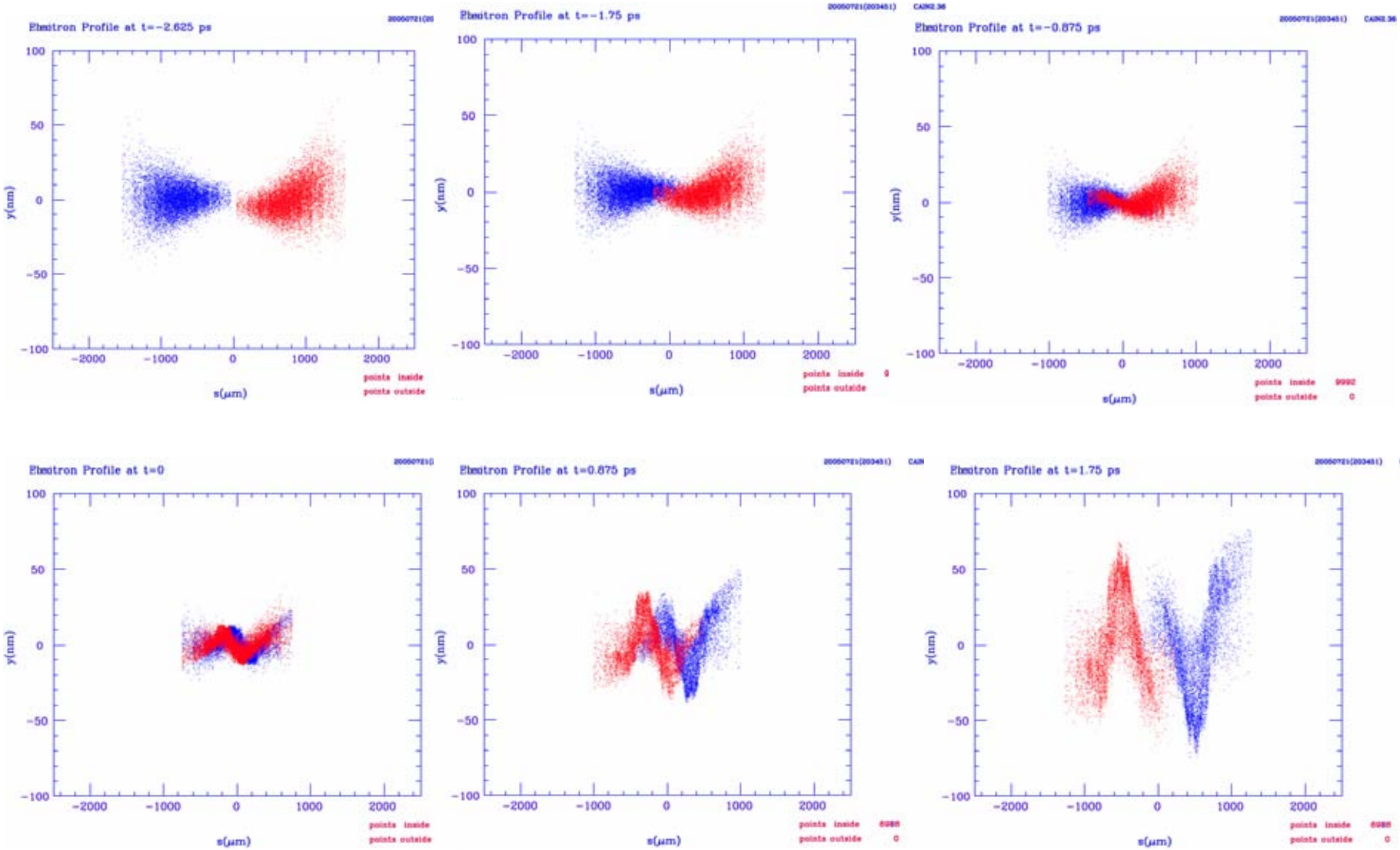
Luminosity (2820 x5 bunch crossing /s) vs. Sqrt(1/sum. of emittance) at the end of Linac

Quad, cavity misalignment 300 micron, cavity tilt 300 micro-rad, Steering and tilt correction



Strong “banana” effect is observed.

Example of collision simulation by CAIN (case of cavity misalignment)
z-y distribution of electrons (blue) and positrons (red)



SUMMARY

- Simulation from the Main Linac entrance to IP was demonstrated
- Computer code developed at KEK, SLEPT, SAD and CAIN were used.
- So called “banana effect” is clearly seen.
- Simulation of DR exit to Linac entrance (including BC) is ready. (Except for Spin)

  Need “Standard” design of BC and transport from DR.